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## A Review of the *Trachysalambria curvirostris* Species Group (Crustacea: Decapoda: Penaeidae) with Description of a New Species

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The taxonomy of the *Trachysalambria curvirostris* species group is clarified based on abundant material from East Asia and other localities in the Indo-West Pacific and the Mediterranean. The following six species, including one new species, are recognized: *T. curvirostris* (Stimpson, 1860), *T. longipes* (Paulson, 1875), *T. aspera* (Alcock, 1905), *T. palaestinensis* (Steinitz, 1932), *T. albicoma* (Hayashi and Toriyama, 1980), and *T. nansei* new species. For nomenclatural stability, a neotype of *Trachysalambria curvirostris* is designated. Species differences are discussed in detail and a key to these species is provided.

**Key Words:** Penaeidae, *Trachypenaeus*, *Trachysalambria*, neotype, new species.

### Introduction

The penaeid genus *Trachysalambria* Burkenroad, 1934 was originally established as a subgenus of *Trachypenaeus* Alcock, 1901. Burkenroad (1934a) divided the genus *Trachypenaeus* s. l. into two divisions. Division I included the species with an epipod on the anterior three pereopods, and Division II, those with an epipod on the third pereopod only. For Division I, Burkenroad (1934b) established the subgenus *Trachysalambria* to include *Trachypenaeus curvirostris* (Stimpson, 1860), *T. similis* (Smith, 1885), *T. similis pacificus* Burkenroad, 1934, *T. constrictus* (Stimpson, 1874), *T. byrdi* Burkenroad, 1934, and *T. brevisuturæ* Burkenroad, 1934, of which all but *T. curvirostris* are distributed in the Atlantic or eastern Pacific (Burkenroad 1934a, 1934b). However, most subsequent authors (cf. Racek and Dall 1965; Pérez-Farfante 1971; Holthuis 1980; Dall *et al.* 1990) did not accept Burkenroad's (1934b) subgeneric division.

Recently, Pérez-Farfante and Kensley (1997) revised *Trachypenaeus* on the basis of differences in the genital organs, particularly the structures of the thelycum, and they recognized four genera including two new, *Megokris* Pérez-Farfante and Kensley, 1997 and *Rimapenaeus* Pérez-Farfante and Kensley, 1997, and *Trachypenaeus* and *Trachysalambria*. We entirely agree with their generic classification. The morphological differences between the genital organs of the four genera are

clear and constant, and certainly indicate separation at the generic, rather than the subgeneric level. The restricted geographical distribution of each genus also supports the generic delineation, although the typically Indo-West Pacific *Trachysalambria* also includes one species from the East Pacific.

Pérez-Farfante and Kensley (1997) reassigned eight species to *Trachysalambria*: *T. curvirostris*, *T. longipes* (Paulson, 1875), *T. aspera* (Alcock, 1905), *T. malaiana* (Balss, 1933), *T. brevisuturæ*, *T. fulva* (Dall, 1957), *T. villaluzi* (Muthu and Motoh, 1979), and *T. albicoma* (Hayashi and Toriyama, 1980). These species can be further divided in four informal groups based on the development of the pereopodal epipods and of the arthrobranch gills on the fourth thoracic somite, and the structure of the petasma. Four species, *T. curvirostris*, *T. longipes*, *T. aspera*, and *T. albicoma*, are characterized by the possession of epipods on the anterior three pereopods, whereas in *T. malaiana* and *T. fulva* the first and second pereopods lack epipods and in *T. villaluzi* the third pereopod is devoid of an epipod. *Trachysalambria brevisuturæ*, which possesses epipods on the anterior three pereopods, is unique in having a rudimentary anteroventral arthrobranch on the fourth thoracic somite and in possessing a tooth-like subdistal projection on the distolateral projection of the petasma.

Of these four groups, we call the first one the *Trachysalambria curvirostris* species group. This group has been confused until now. The most problematic species is the type of the genus, *Trachysalambria curvirostris* (cf. Holthuis 1980; Chan 1998). It is well known as a commercial species in East Asian waters (Kubo 1949; Holthuis 1980; Hayashi 1992). Stimpson (1860) first described *Penaeus curvirostris* based on a single female specimen from Shimoda, Izu Peninsula, Japan. This species has been recorded from various regions in the Indo-West Pacific (previously either as *Penaeus* or *Trachypenaeus*) (cf. Miers 1878; Ortmann 1890; Kishinouye 1896, 1900; Doflein 1902; Balss 1914; De Man 1907, 1911; Parisi 1919; Balss 1924). Paulson (1875) described *Penaeus longipes* from the Red Sea, characterized primarily by its comparatively long fifth pereopod. After comparing specimens from the Persian Gulf with those from Japan, Alcock (1905) described the former as *Trachypenaeus asper*, differing from *T. curvirostris* by a less curved rostrum with more rostral teeth. *Metapenaeus palaestinensis* described by Steinitz (1932) from the Suez Canal was later relegated to a subspecies of *Trachypenaeus curvirostris* by Burkenroad (1959). Holthuis (1980) reviewed this earlier work and concluded that these taxa were conspecific with *Trachypenaeus curvirostris*. In the same year, Hayashi and Toriyama (1980) recognized *Trachypenaeus longipes*, *T. asper*, *T. curvirostris*, and a new species, *T. albicomus*. Partly following Hayashi and Toriyama (1980), Dall *et al.* (1990) reported *Trachypenaeus longipes*, *T. albicomus*, and *T. curvirostris*, but they commented that a comprehensive review of these species was needed.

In order to clarify the taxonomic confusion surrounding *Trachysalambria curvirostris* and its related taxa, we examined numerous specimens from the Indo-West Pacific and the Mediterranean. A neotype for *T. curvirostris* is proposed in the interest of nomenclatural stability, since the type material was lost during the Great Fire of Chicago in 1871 (Evans 1967). Our study has resulted in the recognition of six species, including one new: *T. albicoma*, *T. aspera*, *T. curvirostris*, *T. longipes*, *T. nansei* n. sp., and *T. palaestinensis*. These species are separated from the other species of *Trachysalambria* in having an epipod on the anterior three

pereopods, a T-shaped petasma with the distolateral projections directed laterally, and a triangular thelycum with a V-shaped anterior margin of the posterior plate.

### Materials and Methods

The material examined in this study is deposited at the following institutions: Natural History Museum and Institute, Chiba, Chiba (CBM), Muséum national d'Histoire naturelle, Paris (MNHN), National Fisheries University, Shimonoseki (NFU), National Research Institute of Fisheries Science, Kochi Station, Kochi (NRIFSK), National Science Museum, Tokyo (NSMT), National Taiwan Ocean University, Keelung (NTOU), and Queensland Museum, Brisbane (QM). The specimen size is represented by the carapace length (CL), measured from the posterior margin of the orbit to the midpoint of the posterior margin of the carapace; the body length (BL), from the posterior margin of the orbit to the distal end of the telson; or the total length (TL), from the anterior tip of the rostrum to the distal end of the telson. The rostral teeth count excludes the epigastric spine.

In addition to the material of the *Trachysalambria curvirostris* group, the following specimens of other species previously assigned to *Trachypenaeus* were examined for comparison: *Megokris gonospinifer* (Racek and Dall, 1965), NFU 530-2-852, NFU 530-2-726; *M. granulosus* (Haswell, 1879), NFU 530-2-851, CBM-ZC 2355, NRIFSK-C1066; *M. pescadorensis* (Schmitt, 1931), CBM-ZC2814, CBM-ZC4959; *M. sedili* (Hall, 1961), NRIFSK-C1068; *Trachysalambria malaiana* (Balss, 1933), NFU 530-2-850.

### Taxonomic Account

#### *Trachysalambria curvirostris* group

**Diagnosis.** *Trachysalambria* species with epipod on anterior three pereopods. Petasma T-shaped with distolateral projections directed laterally. Thelycum with V-shaped anterior margin of posterior plate.

**Description.** Females attaining larger size than males. Body densely or sparsely pubescent. Rostrum straight and ascending, or curved dorsally, with 6–10 teeth on dorsal margin, overreaching distal margin of eye. Adrostral carina short, usually disappearing just posterior to level of orbital margin. Carapace with postrostral carina sharp or blunt, extension variable; epigastric spine arising from 0.25 of carapace length; antennal spine marginal, supported by short carina; hepatic spine arising from 0.20 of carapace length, accompanied by short hepatic groove; pterygostomial margin blunt; short longitudinal suture extending posteriorly from base of antennal spine; short transverse suture between coxae of third and fourth pereopods.

First abdominal somite with narrow incision on ventral margin of pleuron. Second somite with 1 or 2 tubercles dorsally. Middorsal carina extending from about anterior 0.33 of third somite to posterior end of sixth somite, terminating posteriorly in acute spine on sixth somite. Posterodorsal margins of fourth and fifth somites incised medially or with small median spine. Sixth somite with acute posteroventral spine. Telson shorter than uropods, tapering to acute tip; dorsal

surface sulcate, usually with 4 pairs of small movable spines on ventrolateral margins in posterior 0.33, second posterior pair smallest and very close to last pair.

Penultimate segment of antennular peduncle 0.50–1.00 times as long as maximum diameter of eye. First and second pereopods with large spine on basis; ischium of first pereopod with or without small spine. Fifth pereopod longer than fourth, sometimes exceeding distal margin of antennular peduncle. Epipods present on anterior 3 pereopods, anterior 2 epipods bifurcate, third one simple. Small exopods present on first to fifth pereopods.

Petasma T-shaped; distolateral projection directed laterally with small anterior projections adjacent to apical opening. Appendix masculina globular. Anterior plate of thelycum on eighth thoracic sternite variable from triangular to more or less oval in general contour, with median depression in posterior part; posterior part of eighth thoracic sternite with V-shaped anterior margin sometimes distinctly notched medially.

**Remarks.** Several authors have tried to classify the species of *Trachypenaeus* s. l. into several informal species groups mainly on the basis of the presence or absence of pereopodal epipods. Motoh and Buri (1984) divided the Indo-West Pacific species of *Trachypenaeus* s. l. into three divisions: the species with epipods on the anterior three pereopods (Division I) included *Trachypenaeus albicomus*, *T. asper*, *T. curvirostris*, *T. gonospinifer* Racek and Dall, 1965, *T. longipes* (Paulson, 1875), and *T. sedili* Hall, 1961. Of these, Pérez-Farfante and Kensley (1997) assigned *Trachypenaeus gonospinifer* and *T. sedili* to *Megokris* based on the morphology of the genital organs. Hayashi (1992) listed *Trachypenaeus albicomus*, *T. asper*, *T. curvirostris*, *T. longipes*, *T. malaianus*, *T. palaestinensis*, and *T. starobogatovi* Ivanov and Hassan, 1976 as the members of the *Trachypenaeus curvirostris* group, which have epipods on the anterior three pereopods and a T-shaped petasma. In contrast to Hayashi's (1992) earlier understanding, we now recognize that *T. malaianus* and *T. starobogatovi* differ obviously from the other members; the former has an epipod on the third pereopod only (Balss 1933; Starobogatov 1972; Motoh and Buri 1984; Liu and Zhong 1988) and the latter has epipods on the first and third pereopods (Ivanov and Hassan 1976).

Of the eight species assigned to *Trachysalambria* by Pérez-Farfante and Kensley (1997), *T. curvirostris*, *T. longipes*, *T. aspera*, and *T. albicoma* are characterized by the possession of epipods on the anterior three pereopods. In addition to these species, *T. palaestinensis* is recognized as a valid species in the present study, although some authors have considered it to be a synonym of *T. curvirostris*. The *Trachysalambria curvirostris* group, therefore, contains *T. albicoma*, *T. aspera*, *T. curvirostris*, *T. longipes*, *T. palaestinensis*, and the new species *T. nansei*. Although the species are difficult to distinguish from one another by the shape of the genital organs alone, careful comparison has shown that the following characters are useful for species recognition: the rostrum, the postrostral carina, the dorsal tubercle on the second abdominal somite, the middorsal carina on the third to sixth abdominal somites, the posterior margin of the fourth and fifth abdominal somites, the dorsolateral carinae of the telson, the ischial spine on the first pereopod, and the length of the fifth pereopod (see Key and Table 1). Although the number of rostral teeth overlaps among species, the average distance between adjacent rostral teeth (rostrum length/number of rostral teeth) relative to carapace length shows a specific pattern in each species (Fig. 1). In each regression equation, intercepts were

Table 1. Comparison of morphological characteristics of the six species of the *Trachysalambria curvirostris* species group.

Character/Species	<i>T. albicoma</i>	<i>T. aspera</i>	<i>T. curvirostris</i>	<i>T. longipes</i>	<i>T. nansei</i>	<i>T. palaestinensis</i>
Pubescence on body						
Rostral curvature (female)	sparse or naked curved dorsally	dense straight	dense curved dorsally	dense straight	dense generally curved dorsally with slightly ventrally curved apex	dense curved dorsally
Dorsal armature near apex of rostrum	armed	armed	unarmed	armed	armed	armed
Common number of dorsal rostral teeth	7, 8	8, 9	6, 7	9, 10	8, 9	7-9
Relative spacing between rostral teeth*	medium	short	long	short	medium	long
Postrostral carina	low, blunt, not reaching posterior end of carapace	low, blunt, reaching posterior end of carapace	low, sharp, reaching posterior end of carapace	high, wide, reaching posterior end of carapace	low, blunt, reaching posterior end of carapace	low, sharp, not reaching posterior end of carapace
Tubercles on 2nd abdominal somite	1, indistinct	1, high	1, low	2, very high	1, high	1, high
Abdominal carina	very low	high	low	very high	high	high
Posterodorsal margins of 4th and 5th abdominal somites	incised	incised	incised	not incised, with spine	incised	incised
Dorsal carinae on telson	blunt	blunt	blunt	blunt	blunt	sharp
Ischial spine on 1st pereopod	very small, sometimes absent	small	conspicuous	absent	small	small
5th pereopod length	not reaching 2nd antennular peduncle segment	exceeding 2nd antennular peduncle segment	not reaching 2nd antennular peduncle segment	exceeding 2nd antennular peduncle segment	exceeding 2nd antennular peduncle segment	not reaching 2nd antennular peduncle segment

\* The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth).

significantly different in all pairs of the species group except three pairs; *T. albicoma*–*T. nansei*, *T. aspera*–*T. longipes*, and *T. aspera*–*T. palaestinensis* (Table 2), although slopes were not significantly different (ANCOVA).

### Key to Species of the *Trachysalambria curvirostris* Group

1. Posterodorsal margins of fourth and fifth abdominal somites not incised, instead terminating in acute spine ..... *Trachysalambria longipes*
- Posterodorsal margins of fourth and fifth abdominal somites each with median incision..... 2
2. Postrostral carina not reaching posterior margin of carapace ..... 3
- Postrostral carina reaching posterior margin of carapace..... 4
3. Postrostral carina blunt; body sparsely pubescent; dorsolateral carinae of telson blunt ..... *Trachysalambria albicoma*
- Postrostral carina sharp; body pubescent; dorsolateral carinae of telson sharp ..... *Trachysalambria palaestinensis*
4. Postrostral carina sharp; rostrum usually with 6 or 7 dorsal teeth and no tooth

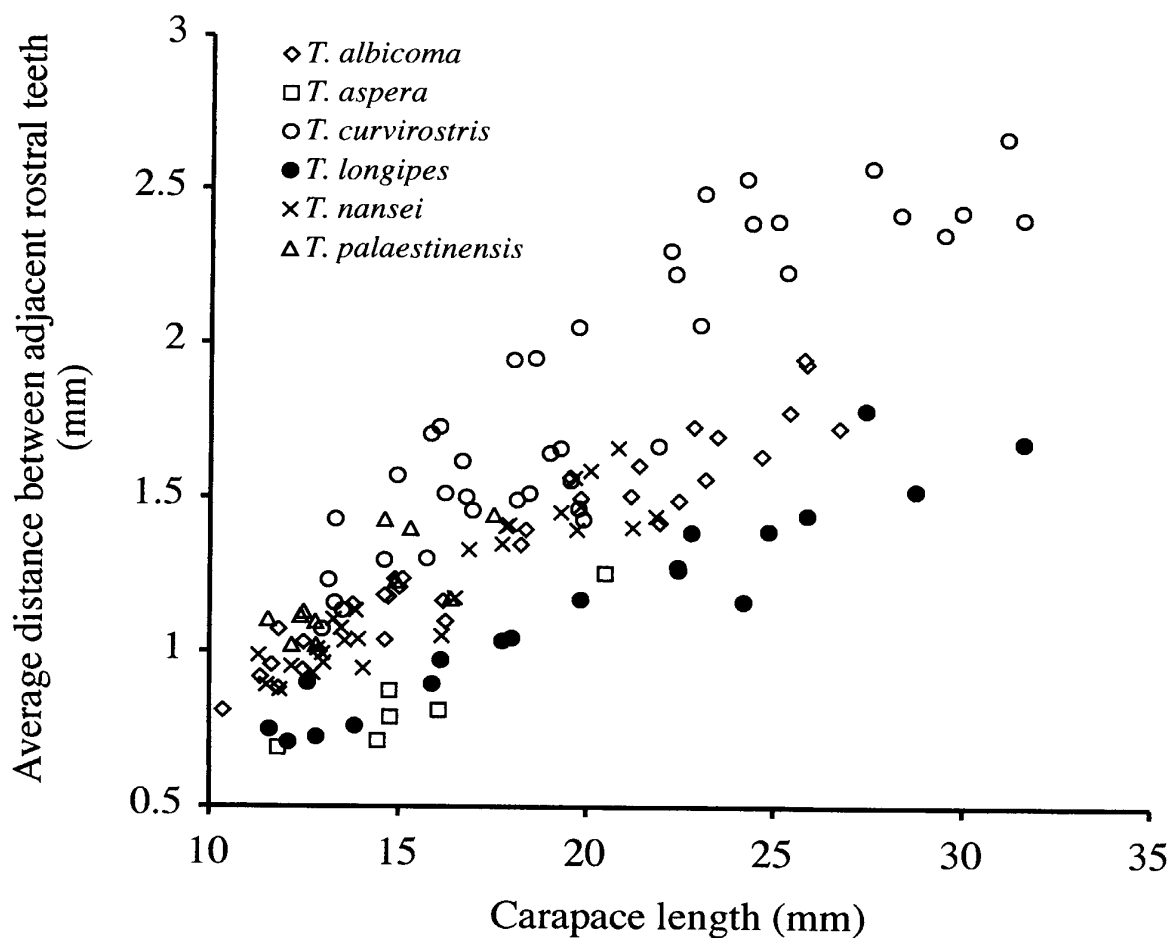


Fig. 1. Average distance between adjacent rostral teeth [rostrum length (mm)/number of rostral teeth], relative to carapace length, in the *Trachysalambria curvirostris* species group.

- near apex ..... *Trachysalambria curvirostris*
- Postrostral carina blunt; rostrum usually with more than 8 dorsal teeth on entire margin ..... 5
5. Rostrum straight in females and slightly curved ventrally in males, not reaching distal margin of second segment of antennular peduncle ..... *Trachysalambria aspera*
- Rostrum generally curved dorsally, with apex ventrally curved in females and straight in males, reaching distal margin of second segment of antennular peduncle ..... *Trachysalambria nansei* n. sp.

***Trachysalambria albicoma*** (Hayashi and Toriyama, 1980)  
(Japanese name: shiraga-saruebi)  
(Fig. 2)

*Trachypenaeus curvirostris*: Maki and Tsuchiya 1923: 45, pl. 3, fig. 1; Yu and Chan 1986: 167 (part), unnumbered figures. [Not *Trachypenaeus curvirostris* (Stimpson, 1860)]

*Trachypenaeus albicomus* Hayashi and Toriyama, 1980: 69, figs 1, 2 (type locality: Tosa Bay, Japan); Toriyama 1980: 79; Toriyama and Hayashi 1982: 87 (list); Hayashi 1986: 75, 248, fig. 35; 1992: 141, figs 75a, 76a, 77a, 78a, 79; Somnuk and Mala 1992: 37, pl. 48; Sakaji 1997: 49 (list).

*Trachysalambria albicoma*: Pérez-Farfante and Kensley 1997: 149 (list); Sakaji *et al.* 2000: 28.

? *Trachypenaeus curvirostris*: Schmitt 1926: 353, pl. 63, fig. 3.

**Type material.** Holotype: female CL 20.7 mm, Tosa Bay, 15 June 1977, coll. M. Toriyama (not located). Paratypes: 5 males CL 14.0–17.0 mm, 5 females CL 18.5–22.0 mm (NFU 530-2-720), same data as holotype.

**Other material examined.** Pacific coast of Japan—Kushimoto: depth 30 m, 8 October 1993, coll. S. Nagai, female CL 28.8 mm (NRIFSK-C1006). Tosa Bay: Mimase Fish Market, Kochi, 6 December 1977, coll. M. Toriyama, 19 males CL 11.1–13.9 mm, 24 females CL 12.9–22.4 mm (NFU 530-2-849); depth 20–40 m, 8 June 1990, coll. M. Toriyama, 8 males CL 13.0–15.1 mm, 28 females CL 15.3–26.7 mm (NFU 530-2-2012); depth 25 m, 20 June 1995, coll. H. Sakaji, 2 males CL 14.7, 15.2 mm, 7 females CL 19.6–22.5 mm (NRIFSK-C1007); depth 25 m, 26 July 1995, coll. H. Sakaji, 3 males CL

Table 2. Significance level of difference in intercept of each regression equation of carapace length against average distance between adjacent rostral teeth (rostrum length/number of rostral teeth) in each pair of the *Trachysalambria* species group (ANCOVA).

species	<i>T. aspera</i>	<i>T. curvirostris</i>	<i>T. longipes</i>	<i>T. nansei</i>	<i>T. palaestinensis</i>
<i>T. albocoma</i>	<0.001	<0.001	<0.001	not significant	<0.05
<i>T. aspera</i>		<0.001	not significant	<0.001	not significant
<i>T. curvirostris</i>			<0.001	<0.001	<0.001
<i>T. longipes</i>				<0.001	<0.001
<i>T. nansei</i>					<0.05

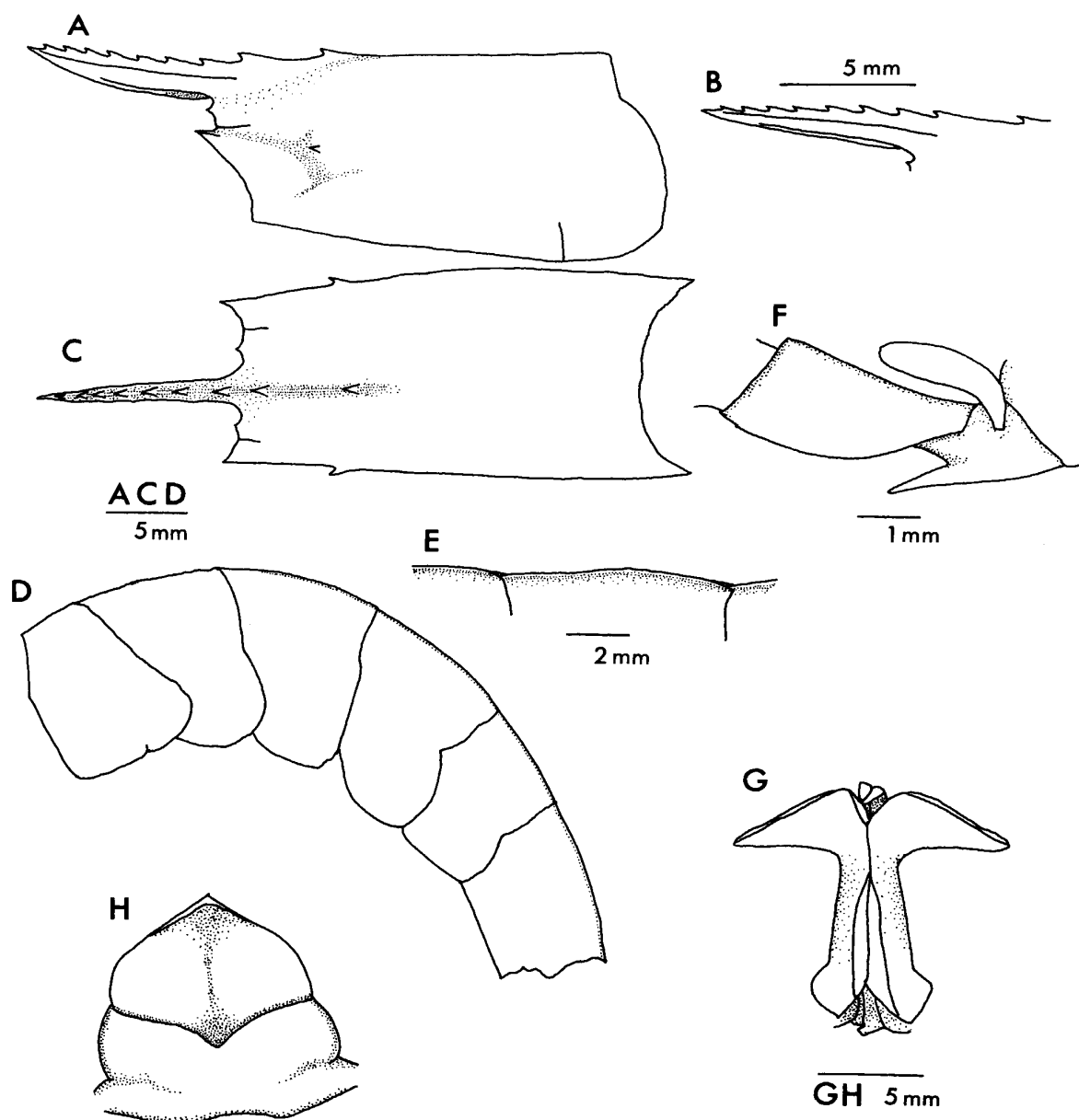


Fig. 2. *Trachysalambria albicoma* (Hayashi and Toriyama, 1980): A, C–F, H, female (CL 25.3 mm, NRIFSK-C1008); B, male (CL 14.9 mm, NFU 530-2-2012); G, male (CL 14.7 mm, NRIFSK-C1008). A, carapace, lateral view; B, rostrum, lateral view; C, carapace, dorsal view; D, abdomen, lateral view; E, posterodorsal margins of fourth and fifth abdominal somites, lateral view; F, ischium and basis of left first pereopod, lateral view; G, petasma, ventral view; H, thelycum, ventral view. Setae omitted.

14.6–15.1 mm, 7 females CL 21.2–26.7 mm (NRIFSK-C1008). Sea of Japan—Toyama Bay: Majimahama, Himi, 15 May 1973, coll. N. Horii, 2 males CL 9.8, 10.2 mm (NFU 530-2-2009); set-net for sparkling enope squid, June–August 1976, male CL 11.0 mm, 10 females CL 10.0–15.3 mm (NFU 530-2-2010); 2 February 1976, coll. N. Horii, male CL 8.6 mm (NFU 530-2-586). Taiwan—Ta-Shi, I-Lan county, depth 20–30 m, 3 August 1986, coll. T. Komai, 2 males CL 11.8, 12.5 mm, 2 females CL 12.9, 18.2 mm (CBM-ZC



2741).

**Description.** Integument of body sparsely pubescent or naked.

Rostrum slightly curved dorsally in females (Fig. 2A), nearly straight in males (Fig. 2B), reaching distal margin of second segment of antennular peduncle in large specimens but falling short of it in small specimens; dorsal margin with 6–9 (usually 7 or 8) teeth (Fig. 2A, B). Postrostral carina faint, usually disappearing just behind epigastric spine (Fig. 2C).

Second abdominal somite with low median tubercle (Fig. 1D), often inconspicuous in small specimens. Third to sixth abdominal somites with low median carina (Fig. 2D, E); posterodorsal margins of fourth and fifth somites incised medially (Fig. 2E). Submedian and dorsolateral carinae of telson blunt.

Penultimate segment of antennular peduncle long, 0.66–1.00 length of eye diameter. Ischial spine on first pereopod inconspicuous or sometimes lacking (Fig. 2F). Fifth pereopod relatively short, reaching or slightly overreaching distal margin of first segment of antennular peduncle.

Anterior plate of thelycum triangular in outline with margin partly folded, depressed in median part, sometimes divided into two parts by median groove; posterior plate of thelycum widely V-shaped, with anterior margin simply notched medially (Fig. 2H).

**Size.** Maximum size CL 25.9 mm and BL 93.3 mm in female, CL 16.2 mm and BL 62.1 mm in male.

**Coloration.** Body pale pink, with scattered small, red chromatophores; uropods red with pale pink outer margin; antennal flagella white (Hayashi 1992).

**Remarks.** *Trachysalambria albicoma* is readily distinguished from other members of this group by having a sparsely pubescent or naked body, a short and faint postrostral carina that does not reach the posterior margin of the carapace, and an indistinct tubercle on the second abdominal somite (Table 1). The number of rostral teeth varied from six to nine: of 118 specimens with an intact rostrum, 66 (55.9%) specimens had eight teeth, 48 (40.7%) had seven teeth, three (2.5%) had nine teeth, and one (0.9%) had six teeth. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is mid-range for this species group as in newly described *T. nansei* (Fig. 1).

Maki and Tsuchiya (1923) reported *Trachypenaeus curvirostris* from Taiwan. They mentioned the sparsely pubescent body integument, the presence of eight dorsal rostral teeth, and a rather short postrostral carina in their specimens; therefore, their specimens are referable, at least partly, to *Trachysalambria albicoma*. The color photographs of *Trachypenaeus curvirostris* given by Yu and Chan (1986) are referable to more than two species, as they suggested. There is little doubt that the specimen indicated as “shiner carapace” represents *Trachysalambria albicoma*, because of the smooth body integument and white antennal flagellum. We confirmed the occurrence of this species in Taiwan based on four specimens from Ta-shi, I-Lan County (CBM-ZC 2741).

Schmitt (1926) identified specimens from Queensland, Australia, as *Trachypenaeus curvirostris* by comparison with Japanese specimens; however, he mentioned that the postrostral carina did not reach the posterior half of the carapace, the upper margin of the rostrum was armed with seven teeth, and the posterior pereopods in his specimens were longer than those of the Japanese specimens. It is possible that Schmitt's specimens represent *Trachysalambria albicoma*, although

they were not examined during the present study.

**Distribution.** Tosa Bay (Hayashi and Toriyama 1980; Toriyama 1980; Toriyama and Hayashi 1982; Hayashi 1986, 1992; Sakaji 1997); Kushimoto, Wakayama Prefecture (present report); Toyama Bay, Sea of Japan (present report); Taiwan (Maki and Tsuchiya 1923; Yu and Chan 1986; present report); Gulf of Thailand (Somnuk and Mala 1992); (?) Queensland, Australia (Schmitt 1926). At depths of 10–60 m, mainly 10–30 m in Japan (Schmitt 1926; Toriyama 1980). The species is recorded from the Sea of Japan for the first time.

***Trachysalambria aspera* (Alcock, 1905)**

(New Japanese name: ara-saruebi)

(Fig. 3)

*Trachypenaeus asper* Alcock, 1905: 531 (type locality: Andaman Sea, India); Alcock 1906: 43, pl. 9, fig. 28, 28a, b; De Man 1911: 9 (list); Starobogatov 1972: 398 (key); Muthu and Motoh 1979: 61; Motoh and Buri 1984: 86, figs 59, 60; Somnuk and Mala 1992: 37 (key), fig. 20, pl. 50.

? *Trachypenaeus asper*: Balss 1915: 12.

*Trachypenaeus curvirostris*: Hall 1961: 98; 1962: 29, figs 110–110b; George 1967: 343; Grey *et al.* 1983: 124, pl. 45; Manning 1987: 577. [Not *Trachypenaeus curvirostris* (Stimpson, 1860)]

*Trachysalambria aspera*: Pérez-Farfante and Kensley 1997: 149 (list).

Not *Trachypenaeus asper*: Kubo 1949: 395, figs 7H', 32K, L, 47L, 59B, 75R, X, 79D. [= *Trachysalambria malaiana* (Balss, 1933)]

**Type material.** Syntypes: Investigator Collection (4054/9, 7220/9, 7218–19/9, 1680/7), Zoological Survey of India, Calcutta, Ganjam coast and Andaman Sea, India (not examined).

**Other material examined.** Taiwan—Tong-Kong: coll. T. Komai, female CL 20.5 mm (CBM-ZC 2812); coll. H-P. Yu, male CL 16.1 mm (NTOU). Philippines—Tigbauan: 3 females CL 14.5–14.8 mm (NRIFSK-C1012, examined by Motoh and Buri 1984). Thailand—Gulf of Thailand: Prachuap Khiri Khan, coll. K. Mochizuki, male CL 11.8 mm (CBM-ZC 1943).

**Description.** Body robust; integument densely pubescent.

Rostrum straight and directed upward in females (Fig. 3A), slightly curved ventrally in males (Fig. 3B), not reaching distal margin of second antennular segment, with 7–10 teeth on entire dorsal margin (Fig. 3A, B). Postrostral carina blunt and wide, nearly reaching posterodorsal margin of carapace (Fig. 3C).

Second abdominal somite with distinct median tubercle (Fig. 3D). Third to sixth abdominal somites with high median carina; posterodorsal margins of fourth and fifth somites incised medially (Fig. 3D, E). Submedian and dorsolateral carinae of telson blunt.

Penultimate segment of antennular peduncle short, nearly 0.5 length of eye diameter. Ischial spine on first pereopod small (Fig. 3F). Fifth pereopod relatively long, reaching or exceeding distal margin of second segment of antennular peduncle.

Anterior plate of thelycum subtriangular with faint concavity on lateral mar-

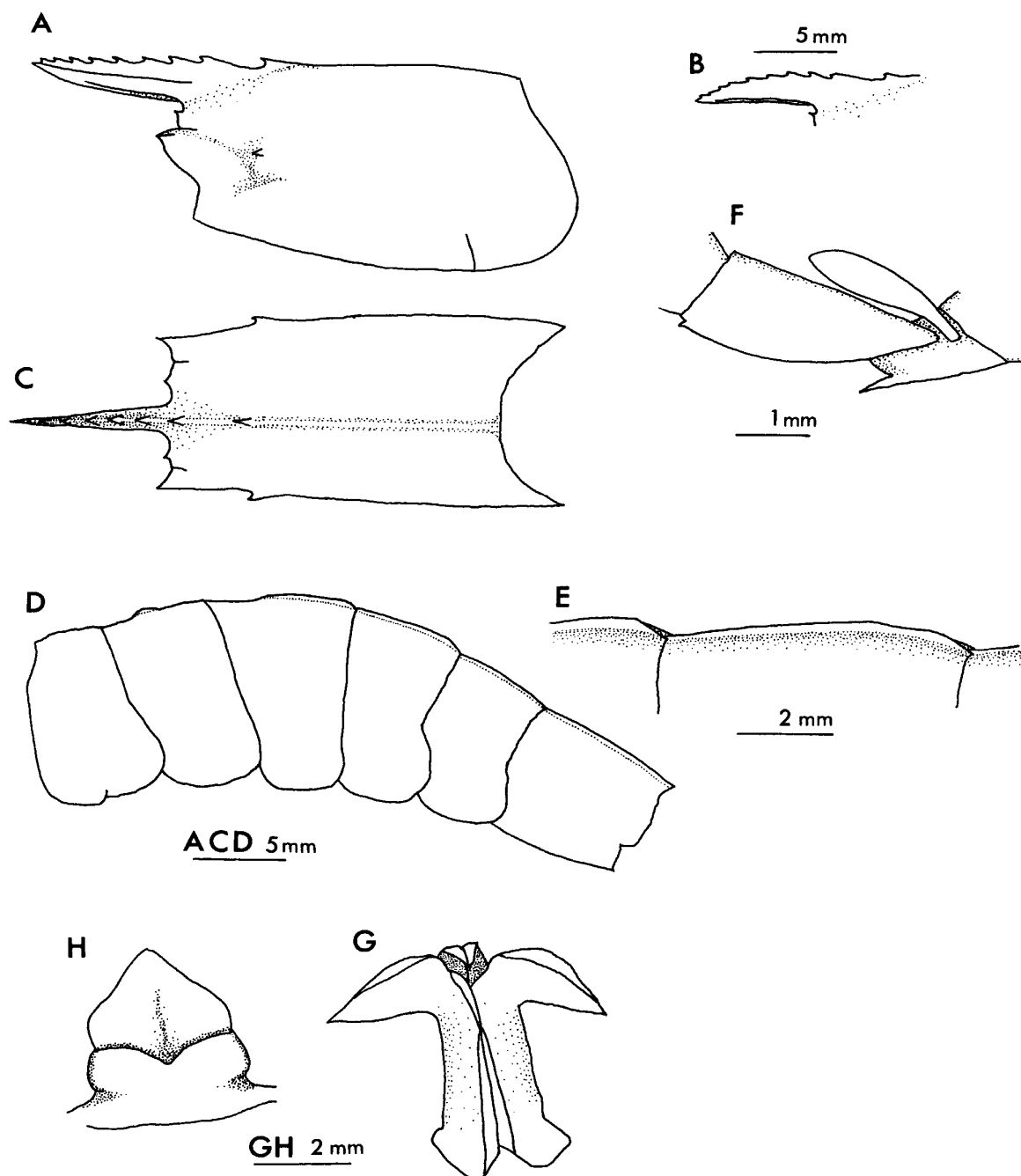


Fig. 3. *Trachysalambria aspera* (Alcock, 1905): A, C–F, H, female (CL 20.5 mm, CBM-ZC2812); B, male (CL 16.1 mm, NTOU); G, male (CL 20.5 mm, CBM-ZC2812). A, carapace, lateral view; B, rostrum, lateral view; C, carapace, dorsal view; D, abdomen, lateral view; E, posterodorsal margins of fourth and fifth abdominal somites, lateral view; F, ischium and basis of left first pereopod, lateral view; G, petasma, ventral view; H, thelycum, ventral view. Setae omitted.

gins and with shallow median depression; posterior plate of thelycum simply notched medially (Fig. 3H).

**Size.** Maximum size CL 20.5 mm and BL 70.8 mm in female, CL 16.1 mm and BL 57.0 mm in male.

**Coloration.** Body and thoracic appendages generally pale pink; posterior 0.66 of rostrum and posterior 0.75 of uropod red; conspicuous saddle-shaped patch on dorsal surface of second abdominal somite red.

**Remarks.** The specific identify of *Trachysalambria aspera* is established based on a careful examination of the original and subsequent descriptions by Alcock (1905, 1906) and the supplemental specimens from Taiwan, the Philippines, and Thailand, although no type or topotypic material from the Indian Ocean has been available for this study. This species is characterized by the combination of the following characters (Table 1): rostrum armed with seven to ten dorsal teeth (usually eight or nine), straight in females; postrostral carina blunt, wide, extending to posterodorsal margin of carapace; tubercles on second abdominal somite conspicuous; middorsal carina on abdomen relatively high; posterodorsal margins of fourth and fifth abdominal somites each with median incision; ischial spine on first pereopod small; fifth pereopod relatively long, reaching or overreaching distal margin of second segment of antennular peduncle. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is short as in *T. longipes* (Fig. 1). In life, *T. aspera* is easily recognized by the presence of a red saddle-shaped patch on the second abdominal somite (cf. Muthu and Motoh 1979; Motoh and Buri 1984; Somnuk and Mala 1992). We also observed the red saddle in our male specimen from Taiwan (NTOU).

In Alcock's (1905, 1906) descriptions of *Trachypenaeus asper*, he distinguished the species from *T. curvirostris* as follows: shorter and straight rostrum with larger number of dorsal rostral teeth; sharper pterygostomial margin of carapace and less distinct cervical groove; shorter antennule and longer fifth pereopod. Although *T. asper* was confirmed as distinct by some authors (Muthu and Motoh 1979; Motoh and Buri 1984; Somnuk and Mala 1992), many authors considered *T. asper* to be a junior synonym of either *T. curvirostris* or *T. longipes* (Schmitt 1926; Ramadan 1938; Racek 1955; Dall 1957; Hall 1961, 1962; Racek and Dall 1965; Holthuis 1980; Liu and Zhong 1988; Chan 1998). As Alcock (1905, 1906) indicated, our specimens of this species also have a shorter and straight rostrum with a larger number of dorsal rostral teeth, and longer fifth pereopods. *Trachysalambria longipes* shares these characters, and this is why Liu and Zhong (1988) considered *Trachypenaeus asper* a junior synonym of that species. Alcock's (1906, fig. 28) illustration of the type specimen clearly shows incisions in the posterodorsal margins of the fourth and fifth abdominal somites, as are present in our specimens. *Trachysalambria longipes* does not have the posterodorsal margins of the fourth and fifth somites incised, but instead has a small median spine in the same position as was originally described for that species.

Dall *et al.* (1990) suggested that Motoh and Buri's (1984) *Trachypenaeus asper* might be *T. albicomus*; the latter authors, however, described the short and straight rostrum with nine to ten dorsal teeth, the postrostral carina reaching the posterior margin of the carapace, and the red saddle on the second abdominal somite. *Trachysalambria albicoma* has a slightly upcurved rostrum with seven to eight dorsal teeth, a short postrostral carina not reaching the posterior margin of

the carapace, and no red patch on the abdomen. We examined some of the specimens reported by Motoh and Buri (1984) and confirmed their identification. We also found a small ischial spine on the first pereopod in those specimens, although Motoh and Buri (1984) described that there was no spine on the ischium of the first pereopod. Somnuk and Mala (1992) mentioned the presence of this ischial spine.

*Trachypenaeus curvirostris* from Singapore reported by Hall (1962, fig. 110) is referable to *Trachysalambria aspera*, because the specimen has a straight rostrum with more than nine teeth. George's (1967) record of *Trachypenaeus curvirostris* from the Andaman Sea must belong to *Trachysalambria aspera*, because of his mention of the small ischial spine on the first pereopod and the long fifth pereopod. *Trachypenaeus curvirostris* from Australia in Grey *et al.* (1983) and Manning (1987) is also referable to *Trachysalambria aspera*, because the former work has a photograph showing a short and straight rostrum with nine teeth, a distinct mid-dorsal tubercle on the second abdominal somite, and a high elevation of the dorsal carina on the third abdominal somite; the latter work describes a red, saddle-shaped patch on the second abdominal somite. It is difficult to be certain of the identity of the *Trachypenaeus asper* specimens of Balss (1915) from the Red Sea because of no morphological description.

As already pointed out by Starobogatov (1972), Kubo's (1949) *Trachypenaeus asper* represents *Trachysalambria malaiana* (Balss, 1933), because of the absence of epipods on the first and second pereopods.

**Distribution.** Vizagapatam and Ganjam coasts, Persian Gulf (Alcock 1905, 1906); Andaman Sea (Alcock 1905, 1906; George 1967); Western Australia (Manning 1987); Australia (Grey *et al.* 1983); Gulf of Thailand (Somnuk and Mala 1992; present report); Philippines (Muthu and Motoh 1979; Motoh and Buri 1984; present report); Singapore (Hall 1961, 1962); Taiwan (Chan 1998; present report). At depths of 42–110 m.

***Trachysalambria curvirostris* (Stimpson, 1860)**

(Japanese name: saruebi)

(Figs 4, 5)

*Penaeus curvirostris* Stimpson, 1860: 44 (type locality: Shimoda, Japan); Miers 1878: 307; Ortmann 1890: 451, pl. 36, fig. 4a, b; Kishinouye 1896: 373 (key); 1900: 23, pl. 6, fig. 4, pl. 7, fig. 10, 10a–c; Doflein 1902: 631; Balss 1914: 11.

*Penaeus anchoralis*: Bate 1888: 258, pl. 35, fig. 1"; Namie 1896: 68, fig. 5. [Not *Penaeus anchoralis* Bate, 1881]

*Parapenaeus curvirostris*: Rathbun 1902: 38.

*Penaeus (Trachypenaeus) curvirostris*: De Man 1907: 436, pl. 33, figs 56–58.

? *Trachypeneus curvirostris*: Alcock 1905: 523; 1906: 53 (list); Gee 1925: 157 (list).

*Trachypenaeus curvirostris*: De Man 1911: 9 (list); Nakazawa 1915: 29, 38, figs 1–4; Parisi 1919: 64; Balss 1924: 44; Hiruma 1925: 425; Urita 1926: 422; Yokoya 1930: 526; 1933: 9; Yu 1935: 166; Yokoya 1939: 262; Nishimura 1939: 382; Yoshida 1941: 16, textfig. 9, pl. 3, fig. 3; Kubo 1949: 393, figs 1V, 4A, 7I', 9B, 21A, 32I, J, 41A–H, 47A–G, 59A, 68K–N, 75Q, W, 79C, 141, 142; Liu 1955: 14, pl. 4, fig. 3, pl. 5, figs 1–5; Dall 1957: 203, fig. 22A–F; Igarashi 1969: 1, pl. 1, fig. 1; Motoh 1972: 35, pl. 4, figs 1, 2; Lee and Yu 1977: 78, figs 52, 53 (in part); Yamashita 1977: 127, fig. 33;

- Sakamoto and Hayashi 1977: 1262; Kim 1977: 127, pl. 14, fig. 8, textfigs 27–29; Kosaka 1979: 167; Hayashi and Toriyama 1980: 71, fig. 2b; Toriyama 1980: 75; Kojima and Hanabuchi 1981: 44 (list); Toriyama and Hayashi 1982: 87 (list); Hayashi 1986: 77, 249, fig. 36; Yu and Chan 1986: 167, 169, unnumbered figures (in part); Ueta 1987: 161; Ishikawa and Imabayashi 1991: 1, figs 1–10; Ronquillo and Saisho 1992: 47, figs 1–6; Hayashi 1992: 143, figs 74, 76b, 77b, 78b, 79; Ueta 1992: 78; Somnuk and Mala 1992: 37, pl. 49; Komai *et al.* 1992: 190 (list); Sakaji 1995: 1; Ronquillo and Saisho 1995: 833, figs 1–12; Ueta 1996: 573 (list); Sakaji 1997: 49 (list).
- ? *Trachypenaeus curvirostris*: Urita 1921: 215; Osada *et al.* 1931: 8, pl. 4; De Bruin 1965: 92; Racek and Dall 1965: 89; Starobogatov 1972: 370, fig. 87 (in part); Champion 1973: 181; Wear and Stirling 1974: 101; Ivanov and Hassan 1976: 1300, figs 1a, 3b; Kurian and Sebastian 1976: 85 (key); Kensley 1981: 18 (list); Paulinose 1982: 664; De Freitas 1987: 34, figs 16, 17; Liu and Zhong 1988: 185, fig. 115 (in part); Anonymous 1993: 32, fig. 16.
- Trachypenaeus (Trachysalambria) curvirostris*: Racek 1955: 235, pl. 4, figs 2, 3, pl. 7, figs 4, 5; Burkenroad 1959: 90, fig. 17.
- ? *Trachypenaeus* aff. *curvirostris*: Ivanov and Hassan 1976: 1300, figs 1b, 3d.
- Trachysalambria curvirostris*: Pérez-Farfante and Kensley 1997: 149 (list), figs 96–98; Sakaji *et al.* 2000: 28.
- Not *Metapenaeus curvirostris* (?): Nobili 1906: 20. [= *Trachysalambria palaestinensis* (Steinitz, 1932)]
- Not *Trachypenaeus curvirostris*: Maki and Tsuchiya 1923: 45, pl. 3, fig. 1; Schmitt 1926: 353, pl. 63, fig. 3. [= *Trachysalambria albicoma* (Hayashi and Toriyama, 1980)]
- Not *Trachypenaeus curvirostris*: Ramadan 1938: 63. [= *Trachysalambria longipes* (Paulson, 1875)]
- Not *Trachypenaeus curvirostris*: Hall 1961: 98; 1962: 29, figs 110, 110a, b; George 1967: 343; Grey *et al.* 1983: 124, pl. 45. [= *Trachysalambria aspera* (Alcock, 1905)]
- Not *Trachypenaeus curvirostris*: Galil and Lewinsohn 1981: 347 (list). [= *Trachysalambria palaestinensis* (Steinitz, 1932)]
- Not *Trachypenaeus curvirostris*: Miyake 1982, pl. 4-4. [= *Trachysalambria nansei* new species]

**Type material.** Holotype: female, Shimoda, Japan, no longer extant (Evans 1967). Neotype: female, CL 27.6 mm, BL 92.7 mm (NSMT-Cr 15146; Figs 4, 5B–E, I), Tosa Bay, Kochi, Japan, 33°30'N, 133°30'E, depth 35 m, 25 April 1996, coll. H. Sakaji, designated herein.

**Other material examined.** Pacific coast of Japan—Choshi: depth 20–30 m, 10 January 1997, coll. T. Komai, female CL 19.8 mm, 3 females CL 20.6–31.6 mm (CBM-ZC 3450); depth 20–30 m, 10 January 1997, coll. T. Komai, 2 males CL 20.3, 21.4 mm, 3 females CL 18.6–31.1 mm (CBM-ZC 3451). Mikawa Bay: Gamagori, March 1996, coll. Bankaku-so-honpo Inc., male CL 15.8 mm, 6 females CL 17.9–22.0 mm (NRIFSK-C1013). Kushimoto: 28 October 1997, coll. H. Misaki, male CL 11.5 mm, 2 females CL 13.7, 16.1 mm (NRIFSK-C1014). Tanabe Bay: Hatakejima, 28 April 1975, coll. T. Sakamoto, 3 females CL 21.0–24.6 mm (NFU 530-2-524). Tosa Bay: depth 30 m, 14 June 1985, female CL 27.1 mm (NFU 530-2-2016); depth 15 m, 24 May 1995, 22 males CL 14.7–17.8 mm, 18 females CL 15.1–24.6 mm (NRIFSK-C1016); depth 35 m, 25 April

1996, male CL 15.4 mm (NRIFSK-C1150); depth 35 m, 25 April 1996, female CL 25.3 mm (NRIFSK-C1152). Seto Inland Sea—Omi Bay: 21 August 1979, coll. T. Takai, T. Yoshioka, K. Hayashi and K. Miki, 4 females CL 11.8–13.9 mm (NFU 530-2-667). Akinada area: 24 May 1989, coll. H. Sakaji, 16 males CL 11.0–16.7 mm, 20 females CL 13.2–27.4 mm (NRIFSK-C1019); 29 August 1989, 4 males CL 13.1–17.0 mm, 4 females CL 19.3–29.9 mm (NRIFSK-C1020). Kii Channel: off Tokushima, depth 30–35 m, 17 December 1988, coll. Y. Ueta, 9 males CL 12.6–17.6 mm, 10 females CL 16.5–26.5 mm (NRIFSK-C1157, examined by Ueta 1992, 1996); May 1991, coll. Y. Ikeda, 3 females CL 21.2–28.6 mm (NRIFSK-C1015). Sea of Japan—Toyama Bay: Majimahama, Himi, 15 May 1973, coll. N. Horii, male CL 10.4 mm (NFU 530-2-599); June–August 1976, set-net for sparkling enope squid, 38 males CL 9.2–16.0 mm, 36 females CL 10.3–21.8 mm (NFU 530-2-580). Shimonoseki: small Danish seine, 14 November 1981, coll. K. Hayashi, 11 females CL 15.9–21.6 mm (NFU 530-2-843). Kyushu—Beppu Bay: small Danish seine, 10 October 1977, coll. Oita Prefectural Fisheries Experimental Station, 3 males CL 15.3–17.8 mm, 10 females CL 21.0–25.9 mm (NFU 530-2-844); small Danish seine, 4 June 1977, coll. Oita Prefectural Fisheries Experimental Station, male CL 13.2 mm, 2 females CL 16.5, 20.4 mm (NFU 530-2-845). Karatsu Bay: 17 November 1984, coll. Y. Tani, 2 females CL 17.1, 18.9 mm (NFU 530-2-1030). East China Sea—30 October 1976, trawl, coll. *Nansei-maru*, male CL 10.4 mm, 3 females CL 12.5–17.5 mm (NFU 530-2-846). Taiwan—April 1996, coll. Bankaku-so-honpo Inc., female CL 19.3 mm (NRIFSK-C1021); Ta-Shi, I-Lan county, depth 20–30 m, 3 August 1996, coll. T. Komai, 4 males CL 7.9–13.1 mm, 2 females CL 17.4, 18.3 mm (CBM-ZC 2742). Australia—Queensland: Gulf of Carpentaria, trawled, CSIRO, KL0476#97, 1976, 2 females CL 18.2, 23.6 mm (QM W18079); 11°58.8'S, 140°41.4'E, dredge, CSIRO, F.R.V. *Southern Surveyor*, Stn. 63, depth 53.5 m, 4 December 1990, 2 males CL 14.6, 15.7 mm, 4 females CL 21.7–26.2 mm (QM W21991).

**Description.** Body densely pubescent.

Rostrum noticeably curved dorsally in females (Fig. 4), nearly straight or slightly curved dorsally in males (Fig. 5A), exceeding distal margin of second segment of antennular peduncle; dorsal margin with 5–9 (usually 6 or 7) teeth, but unarmed in distal 0.20 in females (Figs 4, 5A). Postrostral carina distinct, reaching nearly to posterodorsal margin of carapace (Fig. 5B).

Second abdominal somite with low median tubercle (Fig. 4). Third to sixth abdominal somites each with low median carina (Fig. 4). Posterodorsal margins of fourth and fifth somites incised medially (Fig. 5C). Telson with blunt submedian and dorsolateral carinae, and with 4 pairs of small movable spines ventrolaterally; posteriormost pair largest and second last pair smallest (Fig. 5D, E).

Penultimate segment of antennular peduncle long, 0.66–1.00 length of eye diameter. Ischial spine on first pereopod conspicuous (Fig. 5F). Fifth pereopod relatively short, not reaching distal margin of second segment of antennular peduncle.

Anterior plate of thelycum subtriangular in outline with margin partly folded, depressed in median part, sometimes with faint median groove; posterior plate of thelycum widely V-shaped, with anterior margin simply notched medially (Fig. 5I).

**Size.** Maximum size CL 31.6 mm and BL 102.2 mm in female, CL 20.3 mm and BL 71.2 mm in male.

**Coloration.** Two color morphs are typically recognized; one, body pale pink, relatively darker dorsally, antennal flagella pink, pereopods and pleopods pink with part white, and uropods pink with white margins; the other, body gray, rela-

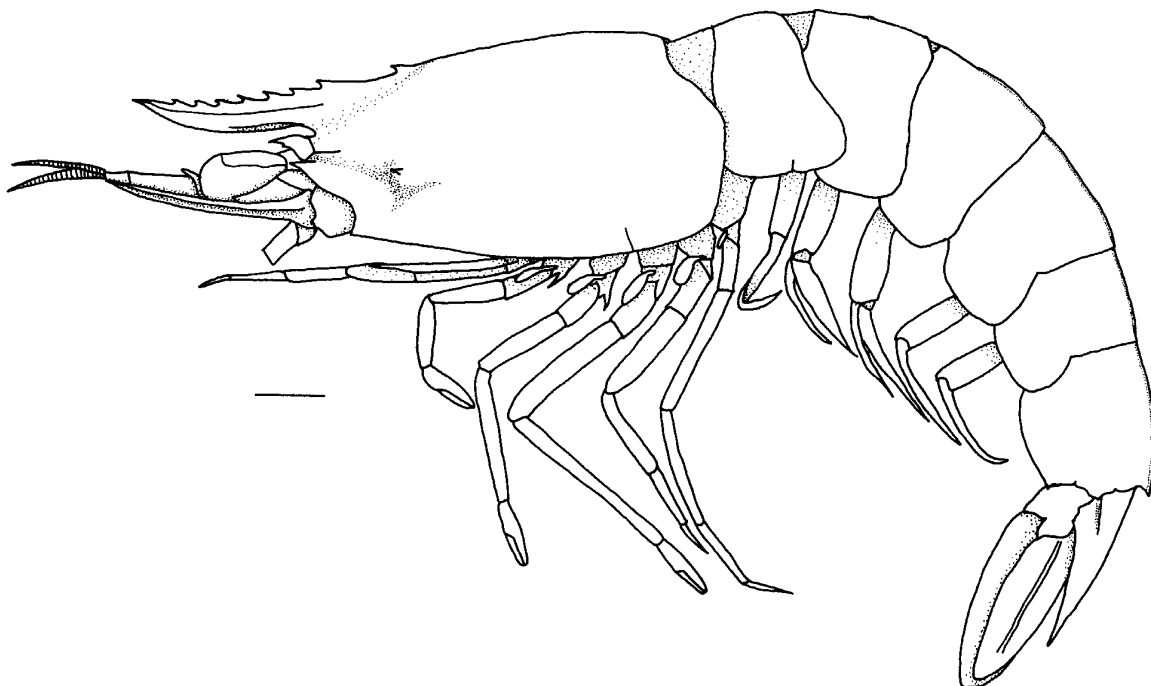


Fig. 4. *Trachysalambria curvirostris* (Stimpson, 1860). Neotype, female (CL 27.6 mm, NSMT-Cr-15146). Setae omitted. Scale=5 mm.

tively darker dorsally, antennal flagella pink, pereopods and pleopods red and partly pink, and uropods red with yellow margins. Some specimens are difficult to assign to morph because of their indefinite coloration.

**Remarks.** The distinct ischial spine on the first pereopod is useful to distinguish *Trachysalambria curvirostris* from other members of this group. The presence of an unarmed subdistal part of the rostrum with usually relatively few rostral teeth is constant in the species, although there is considerable variation in rostrum shape, as Kubo (1949) indicated. Furthermore, the following combination of morphological characters is diagnostic; the low tubercle on the second abdominal somite, the low abdominal carina, the incision of the posterodorsal margins of the fourth and fifth somites, and the short fifth pereopod, slightly overreaching the anterior margin of the first segment of the antennular peduncle (Table 1). The number of rostral teeth varied as follows: of the 223 specimens with an intact rostrum, 115 (51.6%) had seven teeth, 89 (39.9%) had six teeth, 15 (6.7%) had eight teeth, three (1.3%) had five teeth, and one (0.4%) had nine teeth. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is the greatest in this species group (Fig. 1). We could not find any morphological differences distinguishing the two color morphs of this species.

The original description of *Trachysalambria curvirostris* by Stimpson (1860) was very brief and lacked figures. The holotype was presumably lost in the Great Fire of Chicago in 1871 (Evans 1967). As a result, it has been difficult to recognize the difference between *T. curvirostris* and related species, and many subsequent authors have believed that all specimens of *Trachypenaeus s.l.* with a T-shaped petasma and a V-shaped anterior plate of the thelycum must be *T. curvirostris*. In order to stabilize the application of this name, in the context of the subsequently



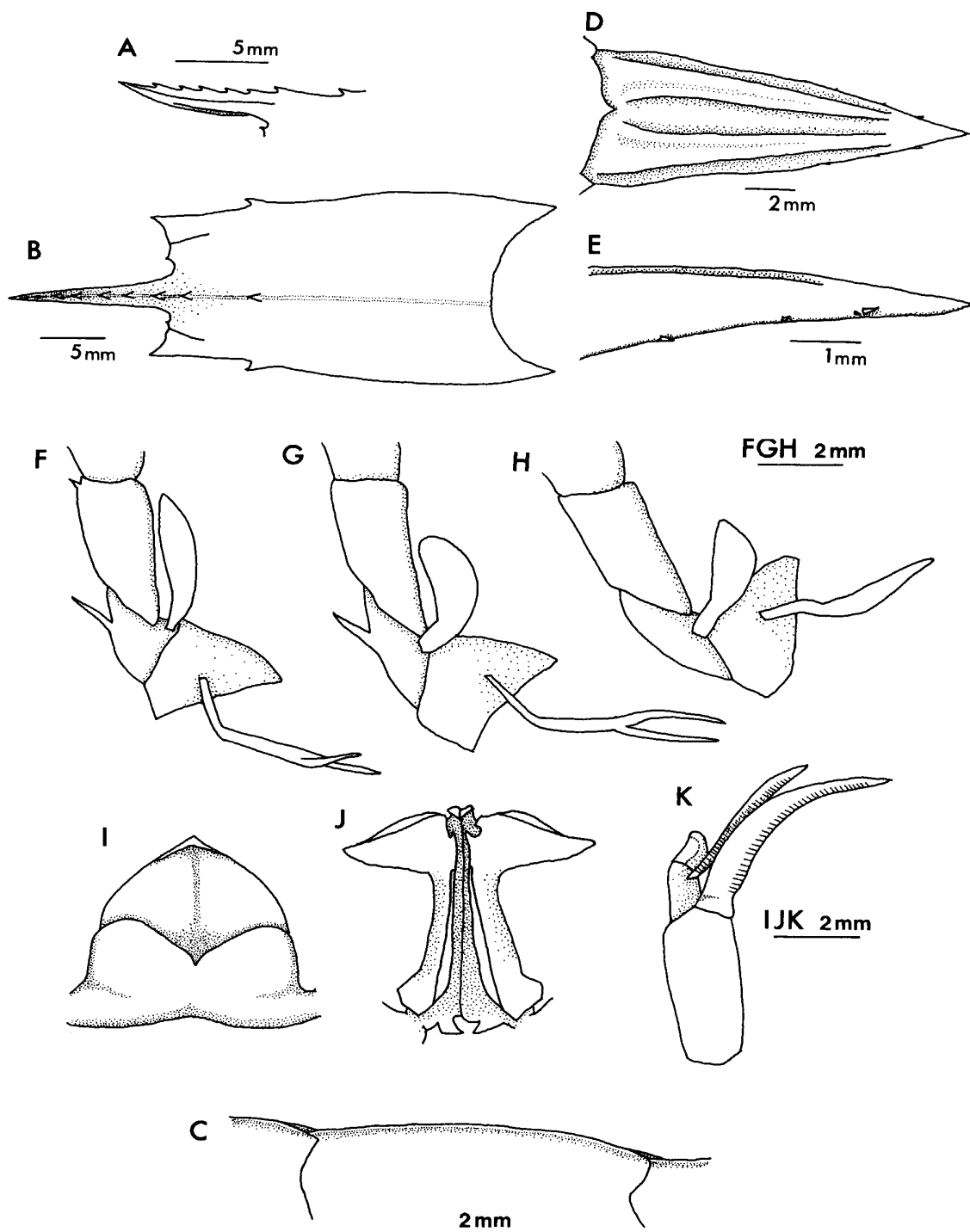


Fig. 5. *Trachysalambria curvirostris* (Stimpson, 1860): A, male (CL 15.2 mm, NFU 530-2-580); B-E, I, neotype, female (CL 27.6 mm, NSMT-Cr-15146); F-H, female (CL 25.3 mm, NRIFSK-C1152); J, K, male (CL 15.4 mm, NRIFSK-C1150). A, rostrum, lateral view; B, carapace, lateral view; C, posterodorsal margins of fourth and fifth abdominal somites, lateral view; D, telson, dorsal view; E, telson, distal part, lateral view; F, ischium, basis, and coxa of left first pereopod, lateral view; G, ischium, basis, and coxa of left second pereopod, lateral view; H, ischium, basis, and coxa of left third pereopod, lateral view; I, thelycum, ventral view; J, petasma, ventral view; K, right second pleopod, frontal view. Setae omitted.

described members of the same species group, a neotype is designated herein.

Although the neotype should be selected from a locality as near as the original type locality, Tosa Bay is about 500 km away from the type locality of *T. curvirostris*, Shimoda. We tried several times to obtain specimens from Shimoda, but it could not be realized. In fact, it is difficult to obtain *Trachysalambria* specimens from Shimoda, because shrimp trawlers do not operate near Shimoda, nowadays. On the other hand, the Pacific coast of southern Japan from Kyushu to the Boso Peninsula, including Shimoda and Tosa Bay, has the zoogeographical uniformity characterized by an effect of the strong warm current, Kuroshio (Briggs 1974). Hence, we select the neotype of *T. curvirostris* from Tosa Bay.

Specimens of *Trachypenaeus curvirostris* reported by Sakamoto and Hayashi (1977), Toriyama and Hayashi (1982), Hayashi (1986, 1992), Ueta (1992, 1996), and Sakaji (1995, 1997), as well as *Trachysalambria curvirostris* in Sakaji *et al.* (2000), are at least partly referable to *T. curvirostris* as confirmed by our direct examination. Specimens of *Trachypenaeus curvirostris* treated by Hayashi and Toriyama (1980), Toriyama (1980), Kojima and Hanabuchi (1981), and Ueta (1987) were partly examined by one of the present authors (Hayashi) during the preparation of these earlier papers, but their material is not included in the present report. It seems that *Trachypenaeus* (*Trachysalambria*) *curvirostris* in Racek (1955) and *Trachypenaeus curvirostris* in Liu (1955), Dall (1957), Motoh (1972), Kim (1977), and Somnuk and Mala (1992) are also referable to *Trachysalambria curvirostris*, judging from descriptions, figures, and/or photographs.

Of the four species of *Trachysalambria* reported from Japanese waters, *T. curvirostris* is the most common there. The following records from Japan are referable to *T. curvirostris* judging from information on morphology and locality: *Penaeus curvirostris* (Miers 1878; Kishinouye 1896, 1900; Doflein 1902; Balss 1914), *P. anchoralis* (in part, Bate 1888; Namie 1896), *Penaeus* (*Trachypenaeus*) *curvirostris* (De Man 1907), *Trachypenaeus curvirostris* (De Man 1911; Nakazawa 1915; Parisi 1919; Hiruma 1925; Osada *et al.* 1931), and *Trachypenaeus* (*Trachysalambria*) *curvirostris* (Burkenroad 1959). *Trachypenaeus curvirostris* reported from northern Japan (Yokoya 1930, 1933, 1939; Nishimura 1939; Igarashi 1969; Kosaka 1979; Komai *et al.* 1992), Korea (Yoshida 1941), and northern Chinese waters (Balss 1924; Urita 1926; Yu 1935) also seems to be referable to *Trachysalambria curvirostris*. It is certain that *Parapenaeus curvirostris* (Rathbun 1902) includes *T. curvirostris* because the collection localities include northern Japan. Komai (1999) confirmed the identification of Ortmann's (1890) *Penaeus curvirostris* from Japan to be true *T. curvirostris* by direct examination.

The material from Taiwan (Lee and Yu 1977; Anonymous 1993) may contain *Trachysalambria curvirostris* and other species, although certain identification is difficult because of their ambiguous description. The photographs of *Trachypenaeus curvirostris* in Yu and Chan (1986) include *Trachysalambria albicoma* and *T. longipes*, in addition to *T. curvirostris*. The present study confirmed the distribution of *T. curvirostris* in Taiwan. The material from the East China Sea (Yamashita 1977) may contain several species.

De Freitas (1987) reported *Trachypenaeus curvirostris* from eastern Africa, bearing nine to 11 rostral teeth and a short and faint postrostral carina. These characters clearly indicate that the specimens do not belong to *Trachysalambria curvirostris*, but to other species of this group.

The following records of *Trachypenaeus curvirostris* reported outside Japanese waters do not contain enough information for certain identification: Urita (1921), Gee (1925), De Bruin (1965), Racek and Dall (1965), Starobogatov (1972), Champion (1973), Wear and Stirling (1974), Ivanov and Hassan (1976), Kurian and Sebastian (1976), Kensley (1981), and Liu and Zhong (1988).

Paulinose (1982) described larvae under the name of *Trachypenaeus curvirostris* based on a plankton sample from the eastern Indian Ocean; however, the identification may not be correct because there is no definite record of adults of this species from this region. The larval development of purported *T. curvirostris* under laboratory conditions was described by using specimens obtained from reared adult females from the Seto Inland Sea (Ishikawa and Imabayashi 1991) and Kagoshima Bay (Ronquillo and Saisho 1992, 1995). The former presumably deals with *Trachysalambria curvirostris* because other *Trachysalambria* species are not reported from the Seto Inland Sea, but it is difficult to be sure of the identification of the latter based only on the locality.

**Distribution.** Many localities around Japan, from Hokkaido along both the Sea of Japan and Pacific coasts through Kyushu to the East China Sea (Stimpson 1860; Bate 1888; Ortmann 1890; Kishinouye 1896, 1900; Namie 1896; Rathbun 1902; Doflein 1902; De Man 1907; Balss 1914; Nakazawa 1915; Parisi 1919; Hiruma 1925; Yokoya 1930; Osada *et al.* 1931; Yokoya 1933, 1939; Nishimura 1939; Kubo 1949; Igarashi 1969; Motoh 1972; Sakamoto and Hayashi 1977; Kosaka 1979; Toriyama 1980; Kojima and Hanabuchi 1981; Toriyama and Hayashi 1982; Hayashi 1986; Ueta 1987; Hayashi 1992; Ueta 1992; Komai *et al.* 1992; Sakaji 1997; Ueta 1997; Sakaji *et al.* 2000; present report); Korea (Yoshida 1941; Kim 1977); China (Balss 1924; Urita 1926; Yu 1935; Liu 1955); Taiwan (Yu and Chan 1986; present report); Gulf of Thailand (Somnuk and Mala 1992); eastern Australia (Racek 1955; Dall 1957; present report). At depths of 10–208 m, mostly shallower than 50 m in Japan (Toriyama 1980).

The range of this species extends as far north as 43°30'N (Nishimura 1939; Igarashi 1969; Komai *et al.* 1992) and thus represents the most northerly distribution of any known penaeid species.

***Trachysalambria longipes* (Paulson, 1875)**

(Japanese name: oki-saruebi)

(Fig. 6)

*Penaeus longipes* Paulson, 1875: 125, pl. 19, fig. 1, 1a (type locality: Red Sea); Nobili 1906: 20, fig. 1.

? *Trachypenaeus* sp.: Maki and Tsuchiya 1923: 46, pl. 4, fig. 3.

*Trachypenaeus curvirostris*: Ramadan 1938: 63; Yu and Chan 1986: 167, 168, unnumbered figure (in part). [Not *Trachypenaeus curvirostris* (Stimpson, 1860)]

? *Trachypenaeus* sp.: Cheung 1960: 65.

*Trachypenaeus longipes*: Starobogatov 1972: 371, fig. 86; Hayashi and Toriyama 1980: 71, fig. 2c; Toriyama 1980: 79; Toriyama and Hayashi 1982: 87 (list); Motoh and Buri 1984: 84, figs 57, 58; Liu and Zhong 1988: 187, pl. 4, fig. 1, textfig. 116; Hayashi 1986: 77, 249, fig. 37; 1992: 144, figs 75b, 76c, 77c, 78c, 79; Somnuk and Mala 1992: 37, pl. 51; Anonymous 1993: 10 (key); Sakaji 1997: 49 (list).

*Trachysalambria longipes*: Pérez-Farfante and Kensley 1997: 149 (list); Sakaji *et al.*

2000: 28.

**Type material.** Holotype: female BL 54.0 mm, Red Sea, not located.

**Other material examined.** Pacific coast of Japan—Tosa Bay: Mimase Fish Market, Kochi, 30 August 1977, coll. M. Toriyama, 2 females CL 23.8, 24.8 mm (NFU 530-2-847); Mimase Fish Market, Kochi, 24 October 1977, coll. M. Toriyama, 20 males CL 17.3–19.2 mm (NFU 530-2-721); depth 65 m, 26 September 1996, coll. H. Sakaji, 2 males CL 17.8, 18.0 mm, 4 females CL 24.9–28.8 mm (NRIFSK-C1022); depth 75 m, 23 January 1997, coll. H. Sakaji, male 15.7 mm, female 19.1 mm (NRIFSK-C1158). Toyo town, Aki county: depth 30 m, 7 July 1991, coll. K. Matsuzawa, female CL 30.0 mm (NFU 530-2-1440). Thailand—Phuket, Andaman Sea, 24 November 1995, coll. T. Komai, male CL 15.9 mm (CBM-ZC 3789).

**Description.** Body robust, especially in mature females; integument densely pubescent.

Rostrum straight, slightly ascending in both sexes, usually not exceeding distal margin of second segment of antennular peduncle; dorsal margin with 9–11 (usually 9 or 10) teeth (Fig. 6A, B). Postrostral carina high, wide, reaching posterior margin of carapace (Fig. 6C).

Second abdominal somite with 2 distinct median tubercles; anterior tubercle situated at midlength, and higher and larger than posterior tubercle (Fig. 6D). Third to sixth abdominal somites with very high median carina (Fig. 6D, E). Posterodorsal margins of fourth and fifth somites not incised, but with small median spine (Fig. 6E). Submedian and dorsolateral carinae of telson blunt.

Penultimate segment of antennular peduncle short, nearly 0.5 length of eye diameter. First pereopod without ischial spine (Fig. 6E). Fifth pereopod relatively long, usually reaching distal margin of second antennular segment, sometimes exceeding third segment.

Anterior plate of thelycum diamond-shaped with straight or sinuous lateral margins, its posterior part largely exposed by deep concavity of anterior margin of posterior plate; no median notch on anterior margin of posterior plate of thelycum (Fig. 6H).

**Size.** Maximum size CL 31.6 mm and BL 100.7 mm in female, CL 18.0 mm and BL 68.5 mm in male.

**Coloration.** Body generally pale pink, relatively darker dorsally; antennal flagella white; rostrum white along dorsal margin, otherwise reddish brown; median carina on abdomen white; uropods red with white margins.

**Remarks.** *Trachysalambria longipes* is immediately distinguished from other members of the group by the possession of two prominent median tubercles on the second abdominal somite and a median spine on the posterodorsal margins of the fourth and fifth somites (Table 1). In the other five species, the second somite bears one median tubercle and the posterodorsal margins of the fourth and fifth somites are incised. The number of rostral teeth varied from eight to eleven: of 45 specimens with an intact rostrum, 28 (62.2%) had nine teeth, 11 (24.4%) had ten teeth, five (11.1%) had eight teeth, and one (2.2%) had 11 teeth. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is short as in *T. aspera* (Fig. 1).

Dall *et al.* (1990) suggested that *Trachypenaeus longipes* reported from the Philippines by Motoh and Buri (1984) might be *T. asper*. Motoh and Buri (1984)

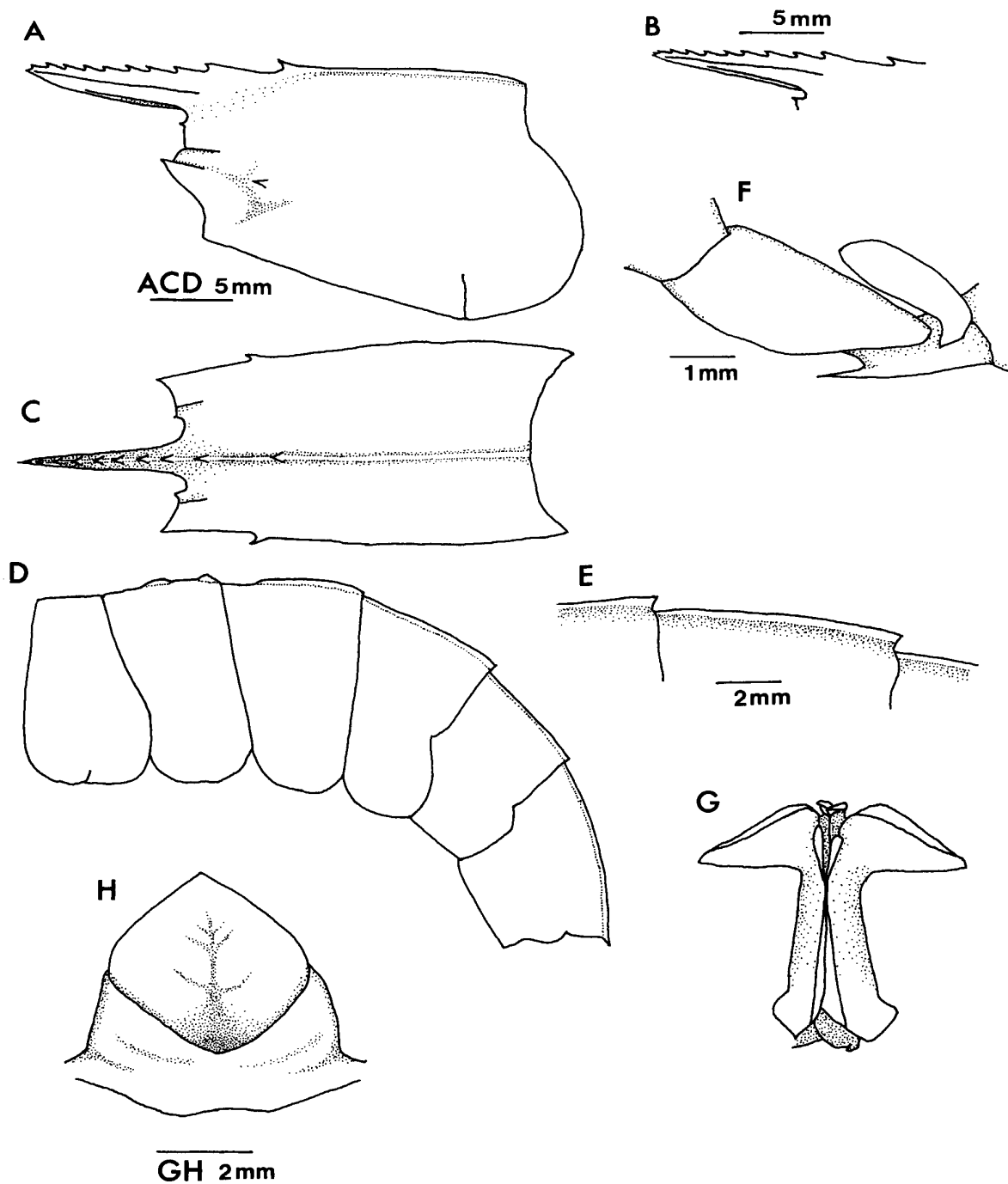


Fig. 6. *Trachysalambria longipes* (Paulson, 1875): A, C–F, H, female (CL 25.2 mm, NRIFSK-C1022); B, male (CL 18.7 mm, NFU 530-2-721); G, male (CL 15.7 mm, NRIFSK-C1158). A, carapace, lateral view; B, rostrum, lateral view; C, carapace, dorsal view; D, abdomen, lateral view; E, posterodorsal margins of fourth and fifth abdominal somites, lateral view; F, ischium and basis of left first pereopod, lateral view; G, petasma, ventral view; H, thelycum, ventral view. Setae omitted.

clearly mentioned the presence of a small median spine on the posterodorsal margins of the fourth and fifth abdominal somites, and their specimens are thus certainly referable to *Trachysalambria longipes*.

Ramadan (1938) mentioned the absence of an ischial spine on the first pereopod and the presence of ten rostral teeth in *Trachypenaeus curvirostris* specimens from the Red Sea. This combination of characters is specific to *Trachysalambria longipes*, not to *T. curvirostris*. One of the color photographs labelled *Trachypenaeus curvirostris* from Taiwan by Yu and Chan (1986), which they called "fat body", shows a short and straight rostrum with ten dorsal teeth and a median spine on the posterodorsal margins of the fourth and fifth abdominal somites. This combination of characters is also specific to *Trachysalambria longipes*. Thus, their record of *T. curvirostris* from Taiwan is referred in part to *Trachysalambria longipes*.

Maki and Tsuchiya (1923) reported a female from Taiwan, under the name of *Trachypenaeus* sp., which had a robust body with heavy pubescence, nine or ten rostral teeth, and the postrostral carina extending to the posterior margin of the carapace. Cheung (1960) reported *Trachypenaeus* sp. from Hong Kong, which was distinguished from *T. curvirostris* by having a long fifth pereopod extending to or beyond the anterior margin of the antennal scale. These records may be referable to *Trachysalambria longipes*.

**Distribution.** Red Sea (Paulson 1875; Nobili 1906; Ramadan 1938); Andaman Sea (Somnuk and Mala 1992; present report); Gulf of Tonkin (Starobogatov 1972); South China Sea (Liu and Zhong 1988); Philippines (Motoh and Buri 1984); Taiwan (Yu and Chan 1986; Anonymous 1993); Tosa Bay, Pacific coast of Japan (Toriyama 1980; Toriyama and Hayashi 1982; Hayashi 1986, 1992; Sakaji 1997; Sakaji *et al.* 2000; present report). At depths of 30–105 m (Starobogatov 1972; Toriyama 1980).

***Trachysalambria nansei* new species**

(Japanese name: nansei-saruebi)

(Figs 7–9)

*Trachypenaeus curvirostris*: Miyake 1982: 11, pl. 4-4. [Not *Trachypenaeus curvirostris* (Stimpson, 1860)]

*Trachypenaeus* sp.: Sakaji 1997: 49 (list).

*Trachysalambria* sp.: Sakaji *et al.* 2000: 29.

**Type material.** Holotype: female, CL 19.8 mm, BL 70.5 mm (NSMT-Cr 15145), Tosa Bay, off Kochi, Japan, 33°30'N, 133°30'E, depth 75 m, 18 August 1996, coll. H. Sakaji. Paratypes: Pacific coast of Japan—Kushimoto, Wakayama Prefecture, 25 September 1996, coll. H. Misaki, female CL 20.6 mm (NRIFSK-C1005). Tosa Bay: depth 45 m, 20 June 1995, coll. H. Sakaji, 7 males CL 11.3–13.5 mm, 9 females CL 13.3–17.7 mm (NRIFSK-C1001); depth 65 m, 19 June 1996, coll. H. Sakaji, 4 males CL 12.2–13.6 mm, 4 females CL 16.5–19.7 mm (NRIFSK-C1002); depth 65 m, 15 July 1996, coll. H. Sakaji, 2 males CL 11.9, 13.4 mm, female CL 20.1 mm (NRIFSK-C1003); depth 65 m, 18 August 1996, coll. H. Sakaji, 2 males CL 7.7, 9.0 mm, 2 females CL 20.5, 22.3 mm (NRIFSK-C1004); depth 75 m, 18 August 1996, coll. H. Sakaji, 2 males CL 12.7, 14.0 mm, 5 females CL 19.4–21.9 mm (NFU 530-2-1914); depth 55 m, 18 August 1996,

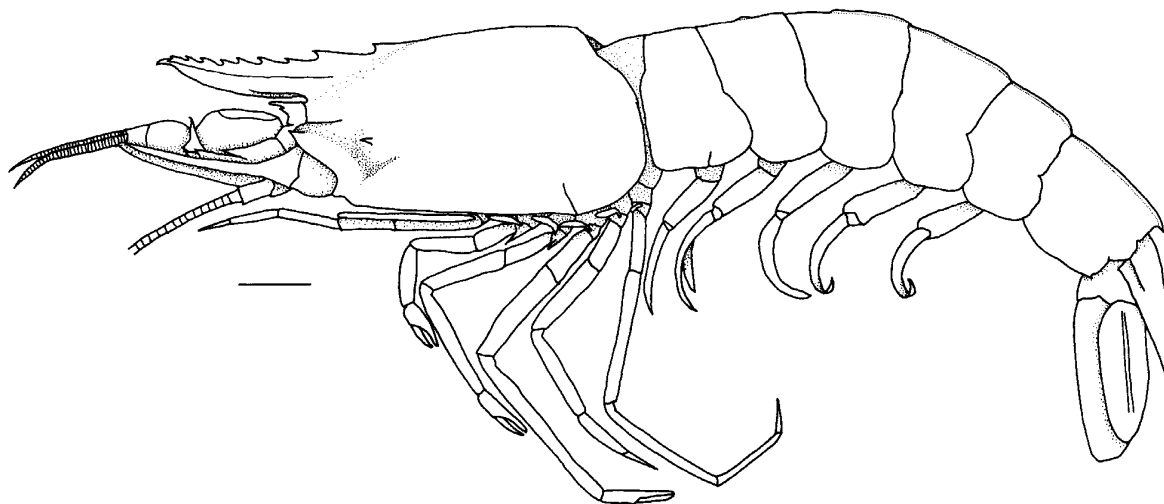


Fig. 7. *Trachysalambria nansei* new species. Holotype, female (CL 19.8 mm, NSMT-Cr-15145). Setae omitted. Scale=5 mm.

coll. H. Sakaji, 2 males CL 12.8, 13.9 mm, 5 females CL 19.6–21.7 mm (NFU 530-2-2011). Taiwan—Tong-Kong, depth 30–50 m, coll. T. Komai, female CL 20.8 mm (CBM-ZC 2812). Australia—NE Queensland, Gilbey Reef, 17°37'S, 146°34'E, trawled, *Markwell Explorer*, depth 63 m, 13 October 1979, 5 males CL 11.0–12.0 mm, female CL 19.9 mm (QM W15848); Stn. 23, 18°30'S, 146°46'E, 8 January 1986, coll. C. Jones, 3 males CL 12.0–12.7 mm, female CL 11.8 mm (QM W12830).

**Description.** Body robust, especially in mature females (Fig. 7); integument densely pubescent.

Rostrum usually reaching, or extending beyond, distal margin of second segment of antennular peduncle, slightly curved dorsally with apex slightly curved ventrally in females (Fig. 7), nearly straight throughout entire length in males (Fig. 8A); dorsal margin with 7–9 (usually 8 or 9) teeth (Fig. 7, 8A). Postrostral carina blunt, wide, extending nearly to posterodorsal margin of carapace (Fig. 8B).

Second abdominal somite with distinct median tubercle (Fig. 7). Third to sixth abdominal somites with high median carina (Fig. 7). Posterodorsal margins of fourth and fifth somites incised medially (Fig. 8C). Telson with blunt submedian and dorsolateral carinae; 4 pairs of small movable spines on distal 0.33 of lateral margin; postermost 2 pairs set closely and distal pair largest (Fig. 8D, E).

Penultimate segment of antennular peduncle short, its length nearly 0.5 of eye diameter (Fig. 7). Basial spine on first and second pereopods large (Fig. 8F, G). Ischial spine of first pereopod small (Fig. 8F). Fifth pereopod long, often exceeding distal margin of second segment of antennular peduncle.

Anterior plate of thelycum triangular in outline with margin partly folded, depressed in median part; posterior plate of thelycum widely V-shaped, with anterior margin simply notched medially (Fig. 8I).

**Size.** Maximum size CL 22.3 mm and BL 76.6 mm in female, CL 14.0 mm and BL 55.0 mm in male.

**Coloration.** Body generally pale pink; antennal flagella pink; pereopods and pleopods pink and partly white; uropods red (Fig. 9).

**Etymology.** This species is named after the Nansei National Fisheries Re-

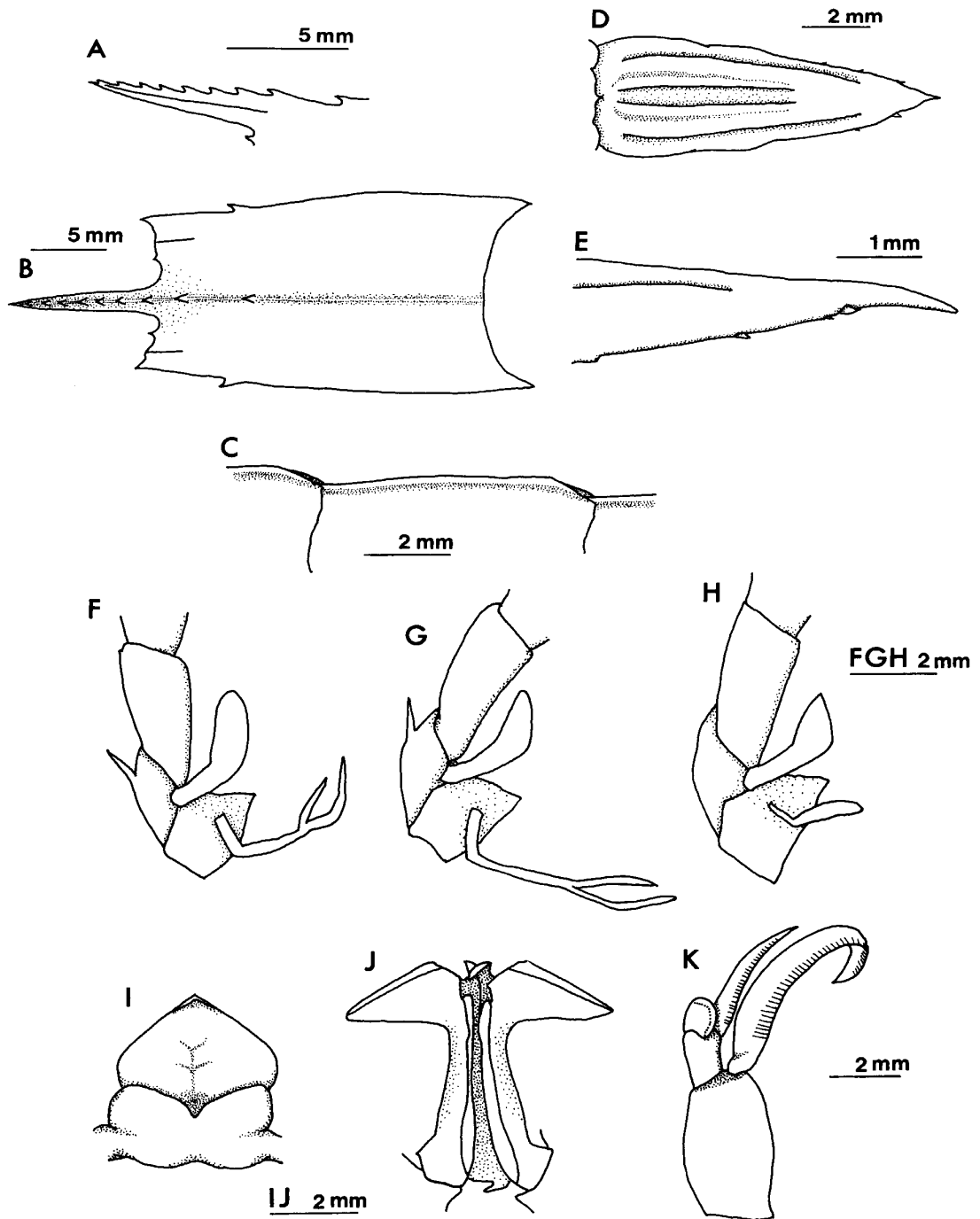


Fig. 8. *Trachysalambria nansei* new species: A paratype, male (CL 12.6 mm, NFU 530-2-2011); B–E, I, paratype, female (CL 20.5 mm, NRIFSK-C1004); F–H, paratype, male (CL 19.8 mm, NRIFSK-C1153); J, K, paratype, male (CL 13.9 mm, NRIFSK-C10043). A, rostrum, lateral view; B, carapace, dorsal view; C, posterodorsal margins of fourth and fifth abdominal somites, lateral view; D, telson, dorsal view; E, same, distal part, lateral view; F, ischium, basis, and coxa of left first pereopod, lateral view; G, ischium, basis, and coxa of left second pereopod, lateral view; H, ischium, basis, and coxa of left third pereopod, lateral view; I, thelycum, ventral view; J, petasma, ventral view; K, right second pleopod, dorsal view. Setae omitted.





Fig. 9. *Trachysalambria nansei* new species. Paratype, female (CL 17.7 mm, NRIFSK-C1001) (Photo by H. Sakaji).

search Institute, where the senior author previously worked. This institution was reorganized and its name changed in 1998, following an administrative reform. The Japanese “nansei” means southwest; noun in apposition.

**Remarks.** *Trachysalambria nansei* is characterized by the following combination of characters: rostrum dorsally curved and usually with eight or nine dorsal teeth; blunt, wide postrostral carina nearly reaching posterior margin of carapace; high tubercle on second abdominal somite; high abdominal carina; incision of posterodorsal margins of fourth and fifth abdominal somites; small ischial spine on first pereopod; and long fifth pereopod overreaching anterior margin of second segment of antennular peduncle (Table 1). The short second segment of the antennular peduncle is useful for distinguishing *T. nansei* from *T. curvirostris*. The number of rostral teeth varied from seven to nine: of 45 specimens with an intact rostrum, 29 (64.4%) specimens had eight teeth, 15 (33.3%) had nine teeth, and one (2.2%) had seven teeth. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is mid-range for this species group as in *T. albicoma* (Fig. 1). *Trachysalambria nansei* is the smallest of the four species occurring sympatrically in Tosa Bay. The specimens from Japan seldom exceed CL 22 mm in females and CL 15 mm in males.

A color photograph of supposed *Trachypenaeus curvirostris* from Tanabe Bay (Miyake 1982) differs considerably from the true *T. curvirostris* by its brownish and robust body, eight teeth on the dorsal margin of the rostrum, and the high median carina on the abdomen. These characters clearly suggest that the specimen represents *Trachysalambria nansei*, although we did not examine it.

**Distribution.** Tosa Bay to Kushimoto and Tanabe Bay of the Kii Peninsula, Pacific coast of Japan (Miyake 1982; Sakaji 1997; Sakaji *et al.* 2000; present report); Taiwan (present report); Queensland, Australia (present report). At depths of 30–75 m.

***Trachysalambria palaestinensis*** (Steinitz, 1932)  
(New Japanese name: minami-saruebi)  
(Fig. 10)

*Metapenaeus curvirostris* (?): Nobili 1906: 20. [Not *Penaeus curvirostris* Stimpson, 1860]

*Metapenaeus palaestinensis* Steinitz, 1932: 161, figs 1–3 (type locality: Haifa Bay).

*Trachypenaeus (Trachysalambria) curvirostris palaestinensis*: Burkenroad 1959: 87, figs 14–16.

*Trachypenaeus curvirostris*: Galil and Lewinsohn 1981: 347 (list). [Not *Trachypenaeus curvirostris* (Stimpson, 1860)]

**Type material.** Syntypes: 2 males TL 62 mm, 5 females TL 72 mm, Haifa Bay, Mediterranean, no longer extant (A. Crosnier, personal communication).

**Other material examined.** Mediterranean—Latakia Fish Market, Syria, 20 November 1987, coll. M. Abe, 7 males CL 8.7–11.6 mm, 4 females CL 9.4–11.3 mm (NFU 530-2-2004). Haifa Bay, Israel, 18 November 1997, coll. B. S. Galil, 3 males CL 11.5–17.0 mm, 6 females CL 12.2–17.0 mm (NFU 530-2-2006). Suez Canal—male CL 14.6 mm, female CL 17.5 mm (MNHN, examined by Burkenroad 1959). Persian Gulf—Kuwait, coll. H. Motoh, male CL 12.9 mm, 6 females CL 16.9–20.6 mm (NFU 530-2-2005).

**Description.** Body densely pubescent.

Rostrum noticeably curved dorsally in both sexes, exceeding distal margin of second segment of antennular peduncle; dorsal margin with 7–9 teeth (Fig. 10A, B). Postrostral carina sharp and clear, only reaching anterior 0.50–0.66 of carapace (Fig. 10C).

Second abdominal somite with small but high dorsal tubercle (Fig. 10D). Third to sixth somites each with high middorsal carina (Fig. 10D, E). Posterodorsal margins of fourth and fifth somites incised (Fig. 10E). Submedian and dorsolateral carinae of telson sharp (Fig. 10F).

Penultimate segment of antennular peduncle long, its length 0.66–1.00 of eye diameter. Ischial spine on first pereopod small (Fig. 10G). Fifth pereopod short, not reaching distal margin of second segment of antennular peduncle, sometimes reaching only anterior margin of eye.

Anterior plate of thelycum generally thickened and rounded with pointed central apex, and median part longitudinally depressed; posterior plate of thelycum widely V-shaped, with faint median notch on anterior margin (Fig. 10H).

**Size.** Maximum size CL 20.7 mm in female, CL 14.6 mm in male.

**Coloration.** Carapace, abdomen, and pleopods generally whitish yellow; thoracic appendages white; rostrum dark gray; uropods dark red.

**Remarks.** *Trachysalambria palaestinensis* is readily separated from the other members of the group by the sharp but short postrostral carina not reaching the posterior margin of the carapace, and the sharp submedian and dorsolateral carinae on the telson (Table 1). The rounded anterior plate of the thelycum is also unique. The number of rostral teeth varied from seven to nine: of 25 specimens with an intact rostrum, 14 (56%) had eight teeth, six (24%) had nine teeth, and five (20%) had seven teeth. The average distance between adjacent rostral teeth (rostrum length/number of rostral teeth), relative to carapace length, is long as in *T.*

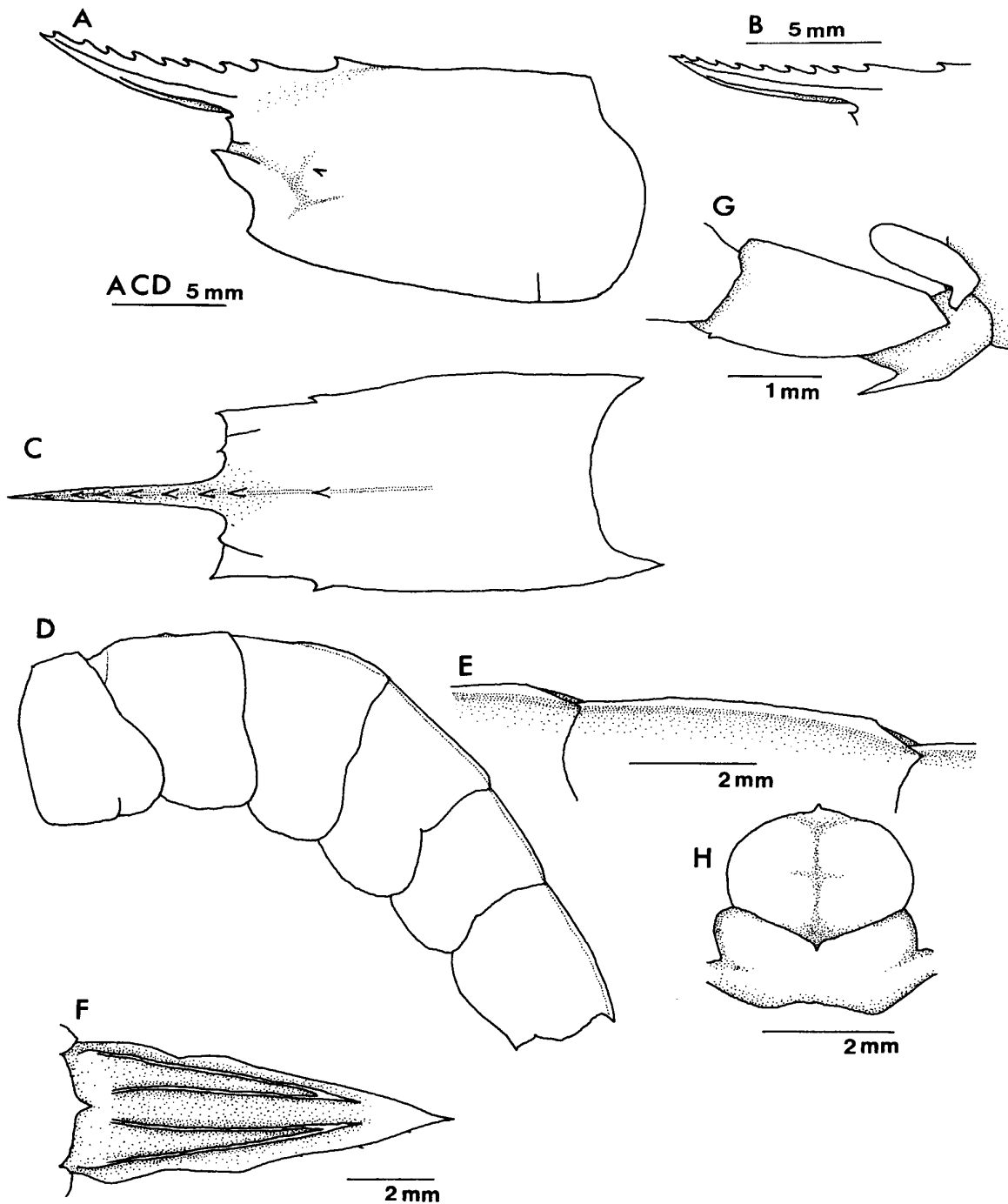


Fig. 10. *Trachysalambria palaestinensis* (Steinitz, 1932): A, C–H, female (CL 16.3 mm, NFU530-2-2006); B, male (CL 11.4 mm, NFU 530-2-2004). A, carapace, lateral view; B, rostrum, lateral view; C, carapace, dorsal view; D, abdomen, lateral view; E, posterodorsal margins of fourth and fifth abdominal somites, lateral view; F, telson, dorsal view; G, ischium and basis of left first pereopod, lateral view; H, thelycum, ventral view. Setae omitted.

*curvirostris*, although only small specimens were observed (Fig. 1).

Steinitz (1932) described *Metapenaeus palaestinensis* based on seven specimens from Haifa Bay, eastern coast of the Mediterranean. Burkenroad (1959) provisionally treated the taxon as a subspecies of *Trachypenaeus curvirostris*, but Galil and Lewinsohn (1981) regarded it as a junior synonym of *T. curvirostris*. We have examined several specimens from the Mediterranean, Suez Canal, and Persian Gulf, including two specimens reported by Burkenroad (1959). They are clearly different from *Trachysalambria curvirostris* in the characters mentioned above. Nobili's (1906) *Metapenaeus curvirostris* from the Red Sea (Massawa, Eritrea) is probably *Trachysalambria palaestinensis* rather than *T. curvirostris*, because he described sharp carinae on the telson. We were able to examine some of the specimens of *Trachypenaeus curvirostris* reported by Galil and Lewinsohn (1981) from the Mediterranean, and the identity of this material is here corrected to *Trachysalambria palaestinensis*. The presence of *T. curvirostris* in the Mediterranean remains unconfirmed.

**Distribution.** Haifa Bay, Israel (Steinitz 1932; present report); Suez Canal (Burkenroad 1959; present report); eastern Mediterranean (Galil and Lewinsohn 1981; present report); Massawa, Red Sea (Nobili 1906); Persian Gulf (present report). At depths of 5–50 m.

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